

TITLE: Simulation Modeling of an Enhanced Low-Emission Swirl-Cascade Burner

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1. ABSTRACT

Introduction and Objectives: “Cascade-burners” were developed by Qubbaj and Gollahalli. The basic idea behind this passive technique is controlling the stoichiometry of the flame through changing the flow dynamics and rates of mixing in the combustion zone with a set of venturis surrounding the flame. Cascade-burners have shown advantages over other techniques; its reliability, flexibility, safety, and cost makes it more attractive and desirable. On the other hand, the application of “Swirl-burners” has shown superiority in producing a stable flame under a variety of operating conditions and fuel types. The basic idea is to impart swirl to the air or fuel stream, or both. This not only helps to stabilize the flame but also enhances mixing in the combustion zone. As a result, nonpremixed (diffusion) swirl burners have been increasingly used in industrial combustion systems such as gas turbines, boilers, and furnaces, due to their advantages of safety and stability. Despite the advantages of cascade and swirl burners, both are passive control techniques, which resulted in a moderate pollutant emissions reduction compared to SCR, SNCR and FGR (active) methods. The present investigation is aimed to study visibility of combining both techniques in what to be named as “an enhanced swirl-cascade burner technology”.

Accomplishments: Natural gas jet diffusion flames in a swirl, cascade, and swirl-cascade burners, were numerically simulated. The numerical computations were carried out using the advanced computational CFDRC package. The finite rate chemistry model was used as the reaction model. The thermal, composition, and flow (velocity) fields for the cascaded (baseline 1), swirling (baseline 2), and the swirling-cascaded flames were numerically simulated, and the optimal configurations were deduced. The numerical results showed that the optimal configurations of the cascaded and swirling baseline flames would not produce the optimal

performance when combined together in a “swirl-cascade burner”. The non-linearity and complexity of the system accounts for such a result, and therefore, all possible combinations need to be considered.

Future Work: Other possible combinations are to be examined. Results are to be analyzed thoroughly. Final Conclusions are to be drawn.

2. LIST OF PAPERS PUBLISHED/CONFERENCE PRESENTATIONS

"Numerical Simulation of an Enhanced Swirl-Cascade Burner," *1st International Energy Conversion Engineering (IECEC)*, August 17-21, 2003, Portsmouth, Virginia. (Conference Proceeding: AIAA-2003-5949)

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